07 - 10 September 2009

PROCEEDINGS

54. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Information Technology and Electrical Engineering - Devices and Systems, Materials and Technologies for the Future

Faculty of Electrical Engineering and Information Technology

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=14089

TECHNISCHE UNIVERSITÄT
ILMENAU

Impressum

Herausgeber: Der Rektor der Technischen Universität Ilmenau
Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c.
Peter Scharff

Redaktion: Referat Marketing
Andrea Schneider

Fakultät für Elektrotechnik und Informationstechnik
Univ.-Prof. Dr.-Ing. Frank Berger

Redaktionsschluss: 17. August 2009

Technische Realisierung (USB-Flash-Ausgabe):
Institut für Medientechnik an der TU Ilmenau
Dipl.-Ing. Christian Weigel
Dipl.-Ing. Helge Drumm

Technische Realisierung (Online-Ausgabe):
Universitätsbibliothek Ilmenau
ilmedia
Postfach 10 05 65
98684 Ilmenau

Verlag:
Verlag ISLE, Betriebsstätte des ISLE e.V.
Werner-von-Siemens-Str. 16
98693 Ilmenau

ISBN (USB-Flash-Ausgabe): 978-3-938843-45-1
ISBN (Druckausgabe der Kurzfassungen): 978-3-938843-44-4

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=14089

Ch. Karcher, V. Minchenya, Y. Kolesnikov, and A. Thess

Industrial application of Lorentz force velocimetry

Introduction

Lorentz force velocimetry (LFV) is a non-contact measuring technique to determine the flow-rate in high-temperature liquid metals. Physically, this technique exploits the basic principles of magnetofluiddynamcis. In more detail, by Ohm's law, eddy currents are generated within an electrically conducting fluid that moves through an externally applied magnetic field. The interaction of these currents and the magnetic field induces Lorentz forces in the melt. These Lorentz forces tend to break the flow. In turn, by Newton's 3rd law, the Lorentz forces exert an accelerating force on the externally arranged magnet system [1]. These reaction force is proportional to the flow-rate and can be measured precisely by high-performance digital strain gages. At TU Ilmenau we have designed [2], [3] and constructed [4] various prototypes of such Lorentz force flowmeters, see Fig: 1. Moreover, we have developed a calibration procedure and have tested the prototypes in industrial environment during the production of secondary aluminum, see Fig. 2.

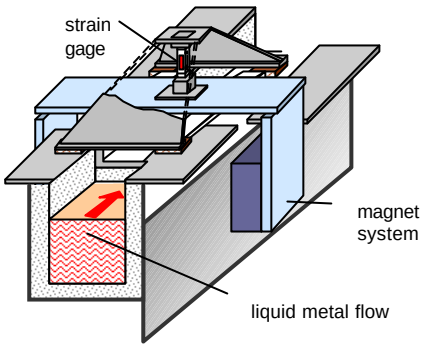

Fig. 1: Prototype of Lorentz force Flowmeter.

Fig. 2: Installation in aluminum industry.

Results

During the production of secondary aluminum, scrap is molten in a rotary furnace. After

tapping, the primary melt flows through open channels into an holding furnace within which the final melt is prepared. Knowledge of the flow-rate has several important advantages. First, the scrap performance can be evaluated during the production process. Secondly, the exact amount of alloying components to be put into the holding furnace in order to reach the final melt composition can be calculated beforehand. This results in saving time, energy, and eventually production costs. Fig. 3 and 4 show the results of a typical run. Fig. 3 shows the measured Lorentz force as a function of time. As the Lorentz force is directly proportional to the flow-rate, the integration of the signal in time gives the mass accumulated in the holding furnace. This is shown in Fig. 4.

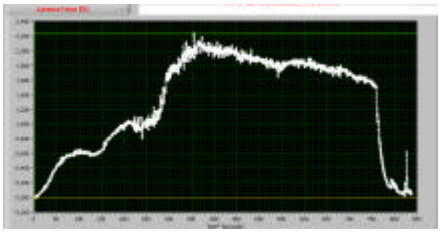

Fig. 3: Measured Lorentz force.

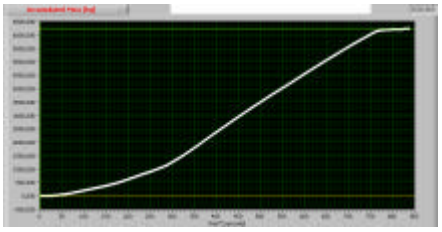

Fig. 4: Calculated accumulated mass.

The statistical evaluation of all successful runs shows that the Lorentz force flowmeter has an uncertainty of measurement of about 1%.

References:

[1] A. Thess, Y. Kolesnikov, Ch. Karcher, E. Votyakov: Lorentz Force Velocimetry – A Contactless Technique for Flow Measurement in High-Temperature Melts; Proc. 5th International Symposium on Electromagnetic Processing of Materials, 731-734, 2006.
[2] A. Thess, E. Votyakov, Y. Kolesnikov: Lorentz Force Velocimetry, Phys. Rev. Lett. 96, 164501, 2006.
[3] A. Thess, Y. Kolesnikov, Ch. Karcher: patent WO 2007/033982, 2007.[4] Ch. Karcher, Y. Kolesnikov, A. Thess: patent DE 10 2007 038 685, 2008.

Authors:

Priv.-Doz. Dr.-Ing. habil. Christian Karcher
Prof. Dr. rer. nat. habil. Yuri Kolesnikov
Dr.-Ing. Vitaly Minchenya
Prof. Dr. rer. nat. habil. André Thess
Institute of Thermodynamics and Fluid Mechanics
Ilmenau University of Technology
P.O. Box 10 05 65
D-98684 Ilmenau, Germany
Phone: +49 3677 69 2455
Fax: +49 3677 69 2411
E-mail: christian.karcher@tu-ilmenau.de
E-mail: yuri.kolesniko@tu-ilmenau.de
E-mail: vitaly.minchenya@tu-ilmenau.de
E-mail: thess@tu-ilmenau.de